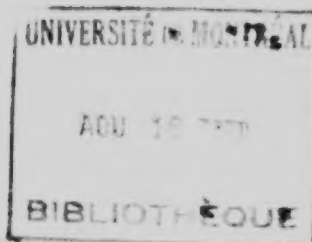


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THE SPECTRUM OF NOVA CYGNI 1920

WITH A

NOTE ON THE SPECTRUM OF NOVA AQUILAE No. 3

BY W. E. HARPER

On August 20th, 1920, a new star was discovered in the constellation Cygnus by Denning, of Bristol, England, while he was engaged in observing and plotting meteor trails. The announcement was cabled to Harvard the following day, but did not reach here until the 23rd. For the six weeks or so previous practically every night had been clear, but a spell of cloudy weather set in about that time which greatly interfered with the observation of the star. Then, too, the cloudy spell interfered with our regular observing program of Boss stars, which became crowded in the early evening hours, and as a consequence the nova was not observed as frequently as would otherwise have been the case. Nevertheless, 19 plates on 12 nights from August 24 to September 28 furnish considerable data, which the following discussion aims to summarize.

The spectra were made with the single prism spectroscope attached to the 72-inch reflector. It had been intended to use a three-prism dispersion if the sharp line stage, noted in former novæ, should be recorded. Such was not the case here on any night in which the star was observed, though from reports such a stage was recorded in England. Sixteen of the spectra were made on Seed 30 emulsion with a medium focus camera, giving a range of spectrum roughly from $\lambda 3700$ to $\lambda 5150$ with a dispersion of 25.7 angstroms per millimetre at $\lambda 4200$, the centre of the plate. The remaining three spectra were made on Ilford Panchromatic plates with a shorter focus camera, taking in a range of spectrum from $\lambda 3700$ to $\lambda 6800$ and having a dispersion of 43.4 angstroms per millimetre at $\lambda 4200$.

From photographic records there seems to have been no star occupying the exact position of the nova—at least none brighter than the 17th magnitude. As it attained a maximum on August 23rd equal to a 2nd magnitude star, it thus increased in brightness

over 15 magnitudes and therefore, while less brilliant at maximum than Nova Aquilæ, it outrivalled it in the extent of its variation. Estimates of its magnitude were made here by the writer when clear weather permitted, either with the naked eye or with binoculars, or sometimes with the 4-inch finder of the telescope. Dr. R. K. Young also kept a record of its magnitude from night to night and, though made quite independently of one another, the naked-eye estimates generally agreed to 0.1 magnitude. The nova was compared with the surrounding stars, the magnitudes of these being taken from Harvard Annals, Volume 50. My own observations, limited in number as they are, are given below.

MAGNITUDE OF NOVA CYGNI

1920,	Aug.	24.7	2.1	glimpsed through clouds
	"	25.7	2.3	
	"	27.7	3.4	
	"	29.7	3.9	
	"	30.7	4.1	little haze
	"	31.7	4.2	
	Sept.	1.7	4.3	
	"	3.7	4.6	
	"	6.7	4.8	
	"	7.7	4.8	
	"	24.7	6.5	brick red
	"	27.7	7.0	observed by J. S. P. Very red
	"	28.7	7.2	very red on slit

While our observations are entirely too few to decide the matter, yet, so far as they go, they do not reveal any oscillations in brightness so marked in Nova Persei and in Nova Aquilæ. The decline was very rapid but continuous.

GENERAL DESCRIPTION OF THE SPECTRUM

The plates of August 24 showed a strong continuous spectrum with broad absorption lines of hydrogen displaced toward the violet corresponding to a velocity of 650 km. per sec. approach—the equivalent of 9 angstroms at the $H\gamma$ region. Broad but faint and more elusive absorption lines which could be identified with enhanced lines of iron and other elements, were also present with displacements similar to the hydrogen lines. The H and K lines of calcium were especially strong and similarly shifted. As there seems to be some difference of opinion as to when emission first made its appearance, it may not be amiss to record that there seems no reasonable doubt of its presence on our plates of this night at G.M.T. 16½ hours. Its presence at $H\gamma$ and farther to the violet is open to question, but at $H\beta$ and at the enhanced lines at $\lambda 4924$, $\lambda 5018$ and $\lambda 5169$ there is a decided strengthening of the continuous spectrum which is unmistakable. Fine sharp H and K lines of calcium undisplaced were also a feature of the spectra as in other recent novæ.

The development of the spectrum during the remaining days of August and the first few days of September was marked by the formation of the usual nova emission bands,

their increase in intensity relative to the continuous spectrum, and by the increase in the displacement of the absorption bands. From a displacement of 9 angstroms (referred to $H\gamma$) on Aug. 24 this increased to 12 on Aug. 25, to 16 on Aug. 27, and seemed to reach a maximum of a little over 17 by the end of the month, the displacement being, as is always the case, to the violet of the normal position of the lines. The equivalent velocities of these displacements are quoted in the Summary of Measures, from which it is seen that if these represent the velocities of the expanding shell of gas then they increased in the interval mentioned from 650 km. to nearly 1200 km. per sec. As already stated, there is some doubt as to the presence of emission bands to the violet of $H\gamma$ on August 24, but they are quite pronounced on plates of the 25th and by the 27th there is a marked difference between the emission and continuous spectrum. On plates of this latter date, while all the emission bands show evidences of structure, yet it is most pronounced in the case of the hydrogen bands, they having two maxima at the sides with faint absorption between. A peculiarity of this structure is that in the case of hydrogen the absorption divides the emission band unsymmetrically, there being more of it to the violet than to the red. The plate taken the last week of September showed that the light from the star was mostly concentrated in the emission bands, $\lambda 4640$ being prominent.

The emission lines were strongest at the red end and rapidly became fainter as the violet was approached. On a panchromatic plate taken on Sept. 2 with a dispersion such that from $H\alpha$ to K was 32 mm, the red $H\alpha$ line is a very outstanding feature of the spectrum. This band is the probable cause of the strong orange colour to the telescopic image during the latter part of September. The widths of the emission bands are much less than was the case in Nova Aquilæ. The three bands to the red of $H\beta$, namely the enhanced lines of iron at $\lambda\lambda 5169$, 5018 and 4924, and $H\beta$ itself are each about 28 angstroms in width, $H\gamma$ 23, $H\delta$ 19 and K 18 angstroms in width. In the case of $H\alpha$ there is no doubt of a decided increase in its width between Aug. 25 and Sept. 2, it being very noticeable from even a casual inspection of the plates. If anything its centre is more to the red on the latter date than on the former, but no great weight is attached to this owing to the low dispersion used and the band may be considered as occupying its normal position.

In one particular at least the spectrum differs from the general trend in Nova Aquilæ in that the main nebular bands N_1 ($\lambda 5007$) and N_2 ($\lambda 4959$) are not present on any of our plates, although a month had elapsed from the star's maximum brightness. In the case of Nova Aquilæ No. 3, whose decline in brightness was much less rapid, only about 9 or 10 days elapsed after the star started to wane before the N_1 band appeared and it was followed within the month's time by the other nebular bands at $\lambda 4363$ and at $\lambda 4959$.

WIDTHS AND POSITIONS OF THE MAIN EMISSION BANDS

An attempt has been made to determine if the main emission bands occupy their normal positions or if they have suffered any displacement, but owing to the lack of definition of their edges, the determinations are not very trustworthy. The following tables, however, give the results, which may be considered as approximate values at

least. The width of the bands is quoted in angstroms, while the displacements are quoted in their equivalent velocities. The mean of all measures indicates a velocity of recession of 31 km. per sec., the equivalent of a redward displacement of 0.5 angstrom at $H\beta$. Owing to the very large probable error of the determination, however, I do not look upon this as having any real significance, and prefer to consider the bands as occupying approximately their normal positions.

WIDTH OF EMISSION BANDS

(In Angstroms)

Plate	H α	5169	5018	4924	H β	H γ	H δ	K
4934.....	26.0			28.4	31.9	28.5	17.3	
4942.....		26.3	27.4	27.7	29.4	26.1		18.6
5011.....	40.8	35.5	25.3	26.4	23.5	24.2	20.2	17.0
5052.....			26.9	28.4	34.0	24.0	20.1	
5081.....			20.6	24.3	32.2	22.1	19.2	
5093.....	39.0				22.5	18.6	17.2	
5111.....					22.6	14.7		
Means.....		30.9	25.0	27.0	28.0	22.6	18.8	17.8

DISPLACEMENTS OF EMISSION BANDS

(km. per sec.)

Plate	5169	5018	4924	H β	H γ	H δ	K
4929.....		+106	- 71	- 51			
4932.....		- 58	+190	+ 74	+170		
4933.....		-196	+174				
4934.....		+135	+185	- 19			
4938.....		+ 73	+ 27	+123	+ 32	- 4	
4939.....		- 88	+ 23	+140			
4939.....	- 10	- 2	+ 24	- 29	+ 77		
4942.....	+ 46	+ 35	+ 11	+ 6	+ 83	+ 29	- 35
5011.....	- 89	- 30	+ 51	- 34	+ 20	+ 80	
5052.....			+ 24	+105	+131	+124	
5081.....							
Means.....	- 18	- 33	+ 64	+ 35	+ 85	+ 57	- 35

Mean of 42 measures on 10 plates = + 31 km. per sec.
 = + 0.5 angstroms at $H\beta$

MEASURES OF ABSORPTION BANDS

Plate	Camera	Date G. M. T.	Velocity Absorption	Lines	Wt.	Sharp H and K	Wt.
4928	Im	1920, Aug. 24-694	- 645	8	2½	-15.2	6
4929	"	" 24-707	- 663	11	2½	-17.4	6
4932	"	" 25-716	- 797	8	1½	-19.6	5
4933	"	" 25-731	- 879	8	2½	-16.6	6
4934	Is	" 25-760	- 847	9	2	-19.3	3
4938	Im	" 27-704	-1103	7	1½	-15.5	6
4939	"	" 27-716	-1099	8	2	-17.1	5
4942	"	" 29-660	-1077	8	1½	-17.2	6
4943	"	" 29-684	-1135	2	½	-16.4	6
4966	"	" 30-710	-1111	2	½	-19.1	5
4961	"	" 30-716	-1190	2	½	-18.0	6
4977	"	" 31-744	-1110	2	½	-17.2	6
4989	"	Sept. 1-715	-1218	2	½	-15.4	5
5010	"	" 2-759	-1196	2	½	-14.7	6
5011	Is	" 2-778	-1164	3	1	-16.0	1
5052	Im	" 6-777	-1185	3	1	-18.0	6
5081	"	" 24-765					
5093	Is	" 27-753					
5111	Im	" 28-727					

The foregoing table summarizes the measures of the absorption bands. At the first, 9 or so of the best of the broad bands were used, but by the end of August, as their positions seemed to undergo no further change, only two or three of the best were measured. These latter results will hence not have quite the accuracy of the first eight, but they will closely approximate the correct values as the interagreement was good. The principal bands besides the hydrogen ones and the calcium H and K were the enhanced iron lines at $\lambda\lambda 5169$, 5018 and 4924. Others were measured and their wave lengths calculated on the assumption that they had suffered displacements similar to the known ones. Thus on the plate of Sept. 6 the following broad absorption bands were present:

4623	4476
4586	4472
4555	4450
4497	4424

SHARP H AND K CALCIUM ABSORPTION

Attention has been called to the fine, undisplaced calcium lines, and the foregoing table also contains the measures of the 16 plates on which the lines are seen. The velocity appears to be quite constant with a mean value -17.0 ± 0.25 km. per sec., practically identical with the component of the solar motion in that direction. Thus, if these lines,

by their position, indicate the real motion of the star, it is practically at rest with respect to the stellar system. Such, of course, was found to be the case in Nova Persei 1901, Nova Geminorum 1912, and Nova Aquilae 1918.

MAIN FEATURES OF SPECTRUM FROM H_{α} TO K

A detailed list of the emission and absorption features of two spectra taken with the short-focus camera are appended. The positions of the various bands were computed by the aid of a Hartmann interpolation formula to the first decimal place of an angstrom and then rounded off to the nearest whole number. Taken in conjunction with the photographs accompanying the article a very fair idea of the spectrum can be had.

DETAILED SPECTRUM

Plate 4934 1920, Aug. 25

absorption line.....	6871	absorption.....	4817
strong emission H_{α}	6557	absorption.....	4756
absorption band H_{α}	6542	broad absorption.....	4606
narrow absorption.....	6382	absorption.....	4540
emission 20 Å wide.....	6195	absorption.....	4495
absorption.....	6142	very broad absorption.....	4472
indefinite absorption.....	5949	very broad absorption.....	4458
wide absorption.....	5880	very broad absorption.....	4434
narrow absorption.....	5595	broad absorption.....	4408
absorption (?).....	5519	broad absorption.....	4388
broad absorption.....	5300	H_{γ} emission 20 Å wide.....	4345
broad absorption.....	5261	H_{γ} absorption.....	4328
very broad absorption.....	5216	very broad absorption.....	4284
absorption (5169).....	5156	absorption.....	4219
emission (5018).....	5016	H_{δ} emission.....	4100
absorption (5018).....	5004	H_{δ} absorption.....	4090
emission (4924).....	4927	sharp calcium H abs.....	3968
absorption (4924).....	4911	broad abs. H and H_{ϵ}	3958
emission H_{β}	4861	sharp calcium K abs.....	3934
absorption H_{β}	4846	broad K absorption.....	3923

Plate 5011

Sept. 2, 1920

H α emission.....	6563	absorption narrow.....	5184
em. ft., 33 A wide.....	6458	emission 36 A wide.....	5170
absorption.....	6440	emission 25 A wide.....	5019
	6389	emission 26 A wide.....	4924
em. 40 A wide.....	6367	emission H β 24 A wide.....	4862
absorption.....	6350	absorption central.....	4864
	6318	absorption 14 A wide.....	4840
emission 28 A wide.....	6302	emission edge diff. band.....	4691
absorption.....	6288	emission strongest.....	4627
	6260	emission edge band.....	4620
emission 26 A wide.....	6244	absorption strong.....	4605
absorption.....	6229	emission 23 A wide.....	4584
	6170	absorption uniform.....	4566
emission 22 A wide.....	6159	emission 20 A wide.....	4549
em. v. ft. broad.....	6001	absorption.....	4537
absorption band.....	5974	emission broad.....	4519
em. strong, 34 A wide.....	5900	emission.....	4484
absorption narrow D (?).....	5897	absorption.....	4478
absorption.....	5878	emission.....	4463
emission faint.....	5652	absorption weak.....	4456
absorption band.....	5640	absorption definite.....	4431
	5582	absorption 12 A wide.....	4375
emission.....	5578	emission H γ 24 A wide.....	4342
absorption 21 A wide.....	5556	absorption central.....	4344
emission.....	5532	emission faint 18 A wide.....	4300
emission very faint.....	5422	abs. faint 20 A wide.....	4282
em. faint 25 A wide.....	5365	emission 14 A wide.....	4234
em. strong 28 A wide.....	5318	emission 15 A wide.....	4176
absorption strong.....	5297	emission H δ 20 A wide.....	4102
em. strong 27 A wide.....	5277	emission H and H γ broad.....	3971
absorption.....	5255	absorption narrow H.....	3968
emission 23 A wide.....	5234	emission K, 19 A wide.....	3933
absorption.....	5216	absorption narrow K.....	3933
emission irreg. 22 A wide.....	5194		

The illustrations used are direct enlargements of the spectrum plates, the magnification being 5.4 diameters. Being prints of enlargements of the original negatives, they are, of necessity, negatives themselves.

While the writer is responsible for the measurement and discussion of the plates, all of the observers shared in the work of securing them.

Dominion Astrophysical Observatory,
Victoria, B.C., Jan. 14, 1921.

NOTE ON THE SPECTRUM OF NOVA AQUILÆ No. 3

The following note contains a brief description of the character of the spectrum on four dates in 1919 and one in 1920, and includes also a more definite determination of the position of the H β emission band in 1918.

The new plates were taken at this observatory with the single prism camera in general use, using Seed 30 plates. They are as follows:

Plate No.	Date G. M. T.	Exposure	Mag.	Remarks
2087	1919, June 3-927.....	20 ^m	7 \pm	image very blue
2155	..... June 18-878.....	60 ^m		
2473	..... July 21-818.....	40 ^m	7.0	
2925	..... Sept. 12-696.....	60 ^m	7.5	image "electric" blue
4149	1920, April 23-986.....	60 ^m		

Since the autumn of 1918 the spectrum of the nova has undergone slight modifications in the region covered by our plates, namely from $\lambda 3900$ to $\lambda 5100$. These changes may be summed up by stating that the hydrogen emissions have vanished—disappearing first from the violet end of the spectrum—and the nebular emissions are more complicated by reason of numerous absorption lines crossing the bands. The emission band, which extended roughly from $\lambda 4600$ to $\lambda 4700$, was very faint in 1919 relative to the other emission bands, and barely a trace of it is seen on the 1920 plate, although all plates could with profit stand more exposure. The continuous spectrum, which at the close of 1918 was almost a negligible quantity, was fairly strong on the plates of June, 1919, but became very weak on the remaining plates. Whether this variation was co-incident with variations in its light similar to that of July, 1918, cannot be stated, as definite determinations of its brightness were not made here. The magnitudes quoted in the table above are very rough estimations, probably within 0.5 m., but it will probably be found when the definite light curve for that year is published that there is such a connection between the two phenomena.

The main portions of the N₁ and N₂ emission bands are well defined, about 12 angstroms in width, with centres at 5007.3 and 4959.5 respectively. The 4363 band is about 55 angstroms wide and its centre is approximately 4364. A noticeable feature of the spectrum is the presence of narrow, apparently isolated, emission strips about 27 angstroms to the violet of the normal position of the bands. Interpreted as velocity displacements they represent an approach of 1750 km. per sec. and thus are identical in position with the least displaced set of absorption lines when they reached their maximum displacement about the end of June, 1918. The impression one gets from a casual inspection of these bands is that these isolated strips are really the violet edges of bands approximately 55 angstroms in width, which have been "eaten out" by absorption, leaving only these strips and the central section of 12 angstroms width.

The measures of these isolated strips on the assumption that they are velocity displacements are given in the following table, plate No. 1041, taken 1918, Dec. 15, being added for reference. The velocities are reduced to the sun only and in computing them I have used the wave-lengths for the nebular bands as given by Wright in Volume 13 of the *Lick Observatory Bulletin*.

NARROW EMISSION STRIPS

	1041	2087	2155	2473	2925	4149
5007.02	-1659.0	-1755.0	-1763.4	-1751.4	-1733.8	-1749.2
4959.09	-1658.5	-1761.0	-1744.0	-1737.9	-1727.6	-1759.2
4861.53	.....	-1739.	-1748.2	.....	.....	.....
4363.37	.....	-1772.2	-1765.3	-1740.5	-1739.1	.....
Mean.....	-1658.8	-1756.5	-1755.2	-1743.3	-1733.5	-1754.2
Reduction to sun	- 10.6	+ 12.6	+ 6.3	- 8.5	- 26.2	+ 24.5
Velocity.....	-1669	-1744	-1749	-1752	-1760	-1730

MAIN EMISSION BANDS

Band	1041	2087	2155	2473
N ₁	5007.2	5007.6	5006.8	5007.2
N ₂	4959.2	4959.3	4959.7	4959.5
H β	4860.0	.....	.....	.....
4363.....	4362.8	4364.6	4364.6	4364.6

The wave lengths of the foregoing bands were obtained by measuring their edges' reducing to wave lengths by a Hartmann interpolation formula, and making correction for the reduction to the sun and also allowing for the shift due to the 20 km. approach of the nova. While the N₁ and N₂ bands are fairly definite, the main intense portions being 12 or 13 angstroms in width, the 4363 band is 55 angstroms wide and its determination is subject to considerable error.

The emission bands become complicated by reason of being crossed by numerous lines, apparently due to some absorbing matter between us and the emission producing substance. One of these absorption lines has been singled out, not only because it is one of the most prominent, but also because of its presence in the hydrogen emission bands all through the latter part of 1918. From the Ottawa spectrograms the writer found the corresponding velocity to be -446 km. per sec., referred to the sun. Lunt and others have since got almost identical results. While the line is not quite so well measurable in these as in the 1918 plates, due mostly to the less dense spectra obtained when the star was faint, yet there is no doubt that it is similar absorption which has made its appearance in the nebular bands.

CHARACTERISTIC ABSORPTION LINE IN EMISSION BANDS

	1041	2087	2155	2473	2925
5007.02	.....	-480.6	.....	-479.4	-445.2
4959.09	.....	-476.7	-483.6	-451.5	-440.5
4861.53	-450.8	.....	-468.8	.....	.....
4363.37	-431.4	-461.0	-430.7	-437.6	.....
Means.....	-441.1	-472.8	-461.0	-456.2	-442.8
Reduction to sun.....	- 10.6	+ 12.6	+ 6.3	- 8.5	- 26.2
Velocities.....	-452	-460	-456	-465	-469

MISCELLANEOUS ABSORPTION LINES

1041	2087	2155	2473	2925	4149	Mean
.....	.....	.....	.....	5036.5	5036.9	5036.7
.....	.....	.....	.....	5028.6	5028.8	5028.7
.....	.....	.....	.....	.....	5022.5	.....
.....	.....	.....	.....	.....	5016.5	.....
.....	.....	.....	.....	.....	4993.5	.....
.....	.....	.....	4988.3	4988.2	4987.4	4988.0
.....	.....	.....	4983.0	4983.2	.....	4983.1
.....	4669.0	.....	.....	.....	.....	.....
.....	4655.2	.....	.....	.....	.....	.....
.....	4549.7	.....	.....	.....	.....	.....
.....	4388.6	4388.5	4389.1	.....	.....	4388.7
.....	4385.3	.....	.....	.....	.....	.....
4382.8	4382.0	4382.8	4382.4	.....	.....	4382.0
.....	.....	4381.4	.....	.....	.....	.....
4376.9	4377.3	4377.4	.....	.....	.....	4377.2
.....	.....	4375.2	.....	.....	.....	.....
.....	.....	4374.7	.....	.....	.....	.....
4371.0	4371.9	.....	4372.2	.....	.....	4371.7
.....	4369.5	.....	4369.2	.....	.....	4369.4
.....	4347.3	.....	.....	.....	.....	.....
.....	4343.5	.....	4342.6	.....	.....	4342.0
.....	4330.7	.....	.....	.....	.....	.....
.....	.....	4341.1	.....	.....	.....	.....

THE EMISSION BAND AT $H\beta$

In Volume IV, page 273, of the Publications of the Dominion Observatory, the writer gave a summary of the emission spectrum of Nova Aquilae No. 3, wherein he found the emission band at $H\beta$ to be about 54 angstroms in width with its centre displaced about 1 angstrom to the violet of its normal position. This was based on 28 plates taken

at Ottawa between July 19 and November 10, 1918, the plates earlier than these indicating a displacement of 0.4 angstrom, but with limits poorly determined. Had these earlier plates been included, the mean displacement would have been in the neighbourhood of 0.8 angstrom. Though the positions of the other bands were more or less roughly measured, this was the only one whose limits seemed sufficiently definite to base any conclusions upon.

In the case of Nova Aurigae 1892, while the literature on the subject is often contradictory, the results of Campbell, whose authority seems the best, showed that the emission bands were displaced to the violet 4 or 5 angstroms, though at times they were recorded much nearer their normal positions. But in recent cases, such as Nova Persei 1901 and Nova Geminorum 1912, where it is only natural to expect more accurate determinations, the emission bands were about 1 angstrom to the red in each case. This circumstance of a negative displacement in Nova Aquilae seemed to impress itself on the writer, and on coming to Victoria a few preliminary measures were made on the plates here with somewhat similar results.

Adams finds corroboration of this violet displacement on the Mount Wilson plates, as recorded in *Astrophysical Journal* for March, 1920, page 126. Lunt discusses the emission spectrum at some length in *Monthly Notices* for March, 1920, and gives results for the 3 hydrogen bands β , γ and δ , as well as for the nebular bands N_1 and N_2 . He finds an average displacement represented by -51.6 km. per sec., the equivalent at $H\beta$ of 0.84 angstroms to the violet. His displacement at $H\beta$ alone is 0.94 angstroms, but this is not comparable to my result because of a correction which I made—and which Dr. Lunt preferred not to make—namely, that required for the 20 km. per sec. approach as adduced from the sharp H and K lines. The consensus of opinion among astronomers, I believe, has been to regard these very fine, sharp calcium lines as reversals indicating the true velocity of the star. On such an assumption a correction of $+0.31$ angstroms would be required to Lunt's displacement, making it 0.63 angstroms. Lunt considers this view erroneous and looks upon the broad emission bands as giving the true velocity of the nova, namely, -51.6 km. per sec.

The purpose of this note is, however, not to discuss this phase of the question, but to give the results of additional measures. Looking over Lunt's results, I began to wonder if I had been too hasty in considering that no reliance could be placed on measures of the other bands. To that end I have examined many of the Victoria plates and 41 plates taken at Ottawa between July 1 and November 30, which the Director, Dr. Klotz, was kind enough to send me, and have not felt like changing my former opinion that measures made upon the other bands are only rough approximations at best. True, the nebular lines are occasionally definite, but the comparison lines are not always of the best. In the early stages $H\gamma$ is sharply defined by the absorption line at its violet edge and fades off very gradually into the continuous spectrum at its red edge and later it becomes blended with the nebular band $\lambda 4363$, so that uncertainty prevails in either case. However, occasion has been taken to measure $H\beta$ again on the 41 Ottawa plates

and on 20 Victoria plates as well covering practically the same interval, with the following result:

20 Victoria plates.....	4860.420
41 Ottawa plates.....	4860.466

The weighted mean, when correction is made for the 20 km. approach, is 4860.76 ± 0.04 , and represents a negative displacement of 0.77 angstroms, approximately the same as the former but less extensive measures.

Dominion Astrophysical Observatory,
Victoria, B.C.,
December 30, 1920.

SPECTRA OF NOVA CYGNI 1920
Taken at the Dominion Astrophysical Observatory, Victoria, B.C.

